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DESCRIPTION OF A NEW GENUS OF NORTH AMERICAN WATER MITES, WITH OBSERVATIONS ON THE CLASSIFICATION OF THE GROUP

By ROBERT H. WOLCOTT

WITH ONE PLATE

I. *STEGANAPSIS* nov. gen.

Diagnosis of the genus: An hydrachnid of the family Hygrobatidae, characterized by the possession of a very delicate exoskeleton in the form of a continuous open mesh-work; with palpi of the character of those of *Arrenurus*, the four basal segments being stout, the fifth small and opposable to the distal end of the fourth; with epimera resembling in form and arrangement those of *Arrenurus*; with legs bearing swimming hairs; and with the genital opening guarded by valves and these in turn flanked by numerous acetabula imbedded in the wall of the body.

At first glance, and as seen from the ventral surface the species which is the type of this genus was taken for an *Arrenurus* on account of the form and relationships of the epimera, and the general character of the structures about the genital opening. This impression was strengthened by an examination of the palpi. But when turned over, the absence of the characteristic chitinous exoskeleton of *Arrenurus* with its prominent furrow, and the general appearance of the specimen as seen from the other side dispelled the illusion. A careful examination shows that it differs in many and important details from the species included in *Arrenurus*, and that it is evidently a type of a related genus, hitherto undescribed, and intermediate between the genus named and some soft-bodied form, from which perhaps that genus is descended.

The name is derived from the Greek *steganos*, covered, and *apsis*, a mesh, and is bestowed in allusion to the chitinous

exoskeleton which gives to the mite, when mounted on a slide and viewed as a transparent object, a characteristic appearance.

Steganapsis arrenuroides nov. sp.

The body of the single specimen in the author's collection is of medium size and broadly elliptical in form, the width being almost precisely three-fourths of the length. It is evenly rounded at both ends, strongly convex above, moderately convex below, and flattened over the epimeral area. The hairs which it bears are long and very slender; on either side of the posterior end of the body is an extremely long and fine hair, and at its outer side a shorter one also very fine. The cuticula is marked by rather conspicuous irregular striae, and beneath it is an exoskeleton consisting of a continuous meshwork (Pl. —, Fig. 1), the openings in which are, over the body, large, practically uniform in size, and with irregular rounded outline. The epimera, the exoskeleton of the palpi and that of the legs are made up of a similar meshwork with finer meshes and with proportionately heavier trabeculae, and this diminution in size of mesh and increase in coarseness of trabeculae is, in any particular part, greater or less, apparently in direct proportion to the strength desirable. At the extreme ends of the epimera about the insertion of the legs the chitin is very thick, and without any trace of such meshes. This meshwork on surface view presents an appearance in a certain degree resembling that seen in *Arrenurus*, but the meshes contain no granular, gland-like cells such as those which occupy the goblet-shaped pores in the thick exoskeleton of that genus and of *Krendowskia*.

The eyes are large, widely separated, and close to the lateral margins of the body.

The maxillary shield is broad and relatively short, with parallel sides and evenly rounded posterior margin. The rostrum (Pl. XXI, Fig. 2, r.), rather similar to that of certain species of *Arrenurus*, is short and blunt.

The mandibles (Pl. XXI, Fig. 3) are more slender than in any species of *Arrenurus* examined, and the proximal segment tapers towards its distal end, becoming, at the articulation with the claw, of the same breadth as the claw which itself is slender and strongly curved.

The palpi (Pl. XXI, Fig. 2) are short and stout with a rela-

tively short ventral margin, and long dorsal margin as seen in *Arrenurus*. Segment 1 is small and narrow; 2, 3, and 4 of about equal thickness, and 5 a mere claw. Segment 2 has a very convex dorsal margin and a shorter straight ventral margin. It possesses several spines, one in the middle of the dorsal margin, two short ones on the distal portion of the median surface toward the dorsal side, and three longer toward the ventral side. Segment 3 is nearly triangular with a very short ventral margin; it bears a long slender spine on the inner surface nearer the dorsal than the ventral margin. The dorsal margin of 4 is quite convex, the ventral moderately so, the distal end being a little over one-third the diameter of the proximal and bearing the claw-like distal segment. This segment 4 bears a flat keel-like expansion which begins on the ventral surface about one-third the way from the proximal end and passes around the distal end to the dorsal surface, its margin forming a rounded angle a little less than a right angle. This keel projects beyond the base of segment 5 at its outer side and bears a coarse spine on its inner surface.

The epimera (Pl. XXI, Fig. 4) form three masses, I and II on either side being approximated, and the first pair being fused along their median edges, the suture between them becoming quite obliterated posteriorly; the median posterior margin of this pair is also indistinct. The space between II and III is of moderate width and less than that separating III and IV of opposite sides. The anterior and median border of this mass forms an even curve, the posterior is straight and runs slightly backward forming a blunt angle towards the outer side. The external ends of the epimera are moderately produced and rounded.

The legs are of moderate length, only the last exceeding the length of the body and that by very little. Leg I is about two-thirds the length of IV and II and III intermediate, with III a trifle longer than II. The segments are, in II and III, in order of length 6, 4, 5, 3, 2, 1; in I, 5 is equal to 4 or even a little longer, and in IV, 4 is even longer than 6. The legs increase regularly in stoutness from I to IV, and the segments from the tip of each leg to the base. The distal segment of each leg bears a pair of small and extremely slender, sharply pointed, simple claws. Spines and hairs are numerous on the legs, and many of them extreme in their

length and fineness. Legs I and II possess a clump of long slender spines at the tip of segment 2, and another at the base of 3, and two long and stouter ones at the tips of 3, 4, and 5, while other spines are few and stout. Leg III has similar spines on 2 and 3, and numerous long hairs toward the tips of 3, 4, and 5, fewer in number on 5. On IV are a great many spines at the tip of 2 and along the whole ventral surface of 3, 4, and 5, varying in length and coarseness, and a profusion of swimming hairs of extreme length and fineness. The distal ends of all segments but the basal of each leg are produced on the anterior and posterior sides, beyond the insertion of the next segment, into two processes; these on segments 2 and 3 of each leg are sharply pointed, while on 4 of each a spine is inserted into the extensor side of this process and on 5, this spine being at the tip, the process becomes bifid. This process varies on different segments but in general the anterior is more prominent than the posterior on any particular segment, and the processes on leg IV are less prominent than on the anterior legs. (See Pl. XXI, Fig. 5.)

The genital area (Pl. XXI, Fig. 4) of the specimen under observation, which is apparently a female, resembles very closely that of a female *Arrenurus*. The opening is flanked by two movable lunate valves, and beyond these numerous acetabula, occurring in an area which is in the form of a band somewhat less in width than the length of these valves, and which runs backward, upward and outward for a short distance on the sides of the body where its end is evenly rounded. These acetabula are set into the meshes in the chitinous exoskeleton. Between this tract and the posterior epimeron of either side is a gland, and posterior to the genital opening and midway between it and the end of the body is the anus.

Measurements:

- Length of body, exclusive of claw...0.868 mm.
- Total length of palpi (average of two).0.204 mm.
- Length of leg I, exclusive of claw...0.617 mm.
- Length of leg II, exclusive of claw...0.699 mm.
- Length of leg III, exclusive of claw..0.729 mm.
- Length of leg IV, exclusive of claw..0.908 mm.

For the single specimen in the collection of the author he is indebted to Mr. James B. Shearer, of Bay City, Michigan,

who collected it at Les Chenaux Islands in northern Lake Huron, during August, 1895.

The name given is suggested by the very close superficial resemblance between this form and the females of *Arrenurus*.

II. KRENDOWSKIA OVATA Wolcott

Wolcott, 1900: 181, Pl. IX, Figs. 1-7.

In material collected in Lamberton Lake near Grand Rapids, Michigan, July 22, 1898, were found six specimens of this species including four nymphs. Both the adults are males with three acetabula on either valve, and in neither is the proboscis protruded.

The nymphs (Pl. XXI, Fig. 6) are about 0.4 mm. in length, and present the broadly oval outline and the strongly convex dorsal surface of the body characteristic of the adult. The surface of the body is covered by an exoskeleton in the form of a delicate chitinous meshwork with fine meshes. There are numerous long hairs, especially long at the posterior end of the body, and a pair just within and anterior to each eye. The palpi are also similar in form to those of the adult. The epimera have much the same form and relationships except that the first two are fused in the median line and the space included between the ends of all seems to be filled in with a thin sheet of chitin. The last pair do not show the characteristic excavation toward the median end. The legs are sparingly furnished with relatively coarse spines and at the distal end of segments III, 5 and IV, 5 and IV, 6 are a few very long and very fine swimming hairs. The genital area is occupied by a chitinous plate which has in general the form of an equilateral triangle all the angles of which are truncated and rounded, and which lies with a more strongly truncated apex anteriorly and with an emarginate base posteriorly. It bears two acetabula on either side.

Thor, in a private communication, has expressed the view that this species is identical with his *Geayia venezuelae*, in which case the name should stand *Krendowskia venezuelae* (Thor).

III. KOENIKEA CONCAVA Wolcott

Wolcott, 1900: 190, Pl. XI, Figs. 15-22, and Pl. XII, Figs. 23, 24.

The result of recent examination of material previously unassorted, and re-examination of material collected several

years ago, has been to extend the known range of this species over a wide area. Specimens are in the author's collection from the following localities:

Massachusetts: Cranberry Lake, Wood's Hole, July 28 and August 13, 1900.

Michigan: Lake St. Clair, August and September, 1893.

Susan, "26," and Twin Lakes, Charlevoix, August 6 and 21, 1894.

Reed's, Fisk's, Round, Soft-water, Lamberton, Muir's, Dean's and Power's Lakes, and Grand River, Grand Rapids, June 27, 1895, and at various dates during July and August, 1895, '96, '97, '98.

Illinois: Fox Lake, Lake County, September 17, 1894 (coll. by H. B. Ward).

Nebraska: Pond at State Fish Hatchery, South Bend, September 2, 1897.

Pond at Wayne, September 8 and 9, 1899 (coll. by Miss Caroline Stringer).

It is a pleasure to record the fact that this genus, dedicated to the author of the first paper of real value on North American hydrachnids, is not only a most attractive form but also by virtue of its wide distribution a characteristic member of our hydrachnid fauna.

IV. TANOAGNATHUS SPINIPES Wolcott

Wolcott, 1900: 194, Pl. XII, Figs. 25-28.

A second specimen of this species, collected in Lamberton Lake near Grand Rapids, Michigan, July 22, 1898, belongs to the same sex as the type specimen and agrees with it in every respect.

V. OBSERVATIONS ON THE CLASSIFICATION OF WATER MITES

Among the recent additions to the literature of the Water Mites, the papers of Thor are noteworthy. Since the work of Neuman, which culminated in his "Sveriges Hydrachnider," for many years the most pretentious work on the subject, no Scandinavian student of the group had appeared, until in 1897 Thor began a series of papers which has become both numerous and valuable, and has given us a very complete knowledge

of the Norwegian hydrachnids. Among the most recent of these is a "Prodromus" (Thor, '00) in which he suggests a division of the group into fourteen families: Limnocharidae, Eylaidae, Hydryphantidae, Hydrachnidae, Lebertiidae, Sperchoniidae, Limnesiidae, Hygrobatidae, Pionidae, Curvipedidae, Atacidae, Brachypodidae, Aturidae and Arrenuridae. Although these families are not characterized and the basis on which they rest is not fully apparent, the paper is interesting to a student of the group as being the first attempt to break up the Hygrobatidae—or Hygrobatinae, as one pleases—into smaller groups, an attempt induced by the rapid increase in the number of described genera. It seems to the writer, however, that in certain respects the proposed arrangement is decidedly a step backward since the families suggested do not represent groups of equivalent value, while its author seems to have passed over all that had been previously accomplished.

Even in the writings of very early writers is observable a tendency to partition the genera of Water Mites, then few in number, between groups of higher rank, and Leach (15) in 1815 recognized two families; the Eylaides with one genus, *Eylais*, and the Hydrachnides with two genera, *Hydrachna* and *Limnochares*. Koch (37), in 1842, included under the order Acari, Section 1 or Water Mites, containing forms with movable swimming hairs, two families, Hygrobatides and Hydrachnides. To the former, characterized by the possession of two eyes, he assigned the genera *Atax*, *Nesaea*, *Piona*, *Hygrobates*, *Hydrochoreutes*, *Arrenurus*, *Atractides*, *Acercus*, *Diplodontus* and *Marica*; to the latter, characterized by the presence of four eyes, *Limnesia*, *Hydrachna*, *Hydryphantes*, *Hydrodroma* and *Eylais*. Under Section 2, or Swamp Mites, containing forms with a prominent snout, he included *Limnochares*, *Thyas*, *Smaris* and *Alycus*, of which neither of the last two have been again grouped with the Water Mites until Nordenskiöld's proposed arrangement, given hereafter. Kramer (77) divided the hydrachnids into four families: Hydrachnidae, with mandibles one-jointed, lancet-shaped (type *Hydrachna*); Eylaidae, with mandibles dwarfed and consisting of two hooklets (type *Eylais*); Hygrobatidae, with mandibles distinctly two-jointed, the distal claw-like (types *Nesaea* and *Arrenurus*); and Limnocharidae, with mandibles and labrum fused forming a firm capitulum (type *Limnochares*).

Haller (81a) gave to the "Hydrachnidae" the rank of a sub-order and recognized two families on the basis of the position of the eyes; Medioculatae, including *Limnochares* and *Eylais*, and Lateroculatae, including all the other genera. In 1891 Canestrini (91) raised the "Hydracarini" to the rank of an order, and included under it three families—Halacaridae, Limnocharidae and Hydrachnidae. The first, or Marine Mites, are by most authorities separated entirely from the Water Mites, while of the two other families the former is equivalent to Haller's Medioculatae, and the latter to his Lateroculatae.

Thus the matter of systematic arrangement stood, when in a later paper Kramer (93) by distinguishing clearly between three principal types of larvae, and making this the basis of his arrangement of the genera, proposed the following, which seems to the writer the first logical classification:

Order Prostigmata—

- Fam. 1—Hydrachnidae (larval type I).
- Fam. 2—Hygrobatidae (larval type II).
- Fam. 3—Eylaidae (larval type III).
- Fam. 4—Trombididae.

Piersig (97) in his great work on "Deutschlands Hydrachniden" reduced the Hydrachnidae to the rank of a family with five sub-families—Limnocharinae, Hydrachninae, Eylainae, Hydryphantinae, and Hygrobatinae. Nordenskiöld (98) later canvassed very carefully the morphological and systematic relationships of the Hydrachnidae and came to the conclusion that the term Trombididae should include a number of sub-families, representing two lines of descent, to the forms included under one of which he applied the term Trombidiformes, and to the others Rhyncholophiformes. The former contains, according to him, the sub-families Trombidinae, Hydryphantinae, and Hygrobatinae on the one hand, and Eylainae and Limnocharinae on the other; the latter the Hydrachninae, Rhyncholophinae, including the genus *Rhyncholophus*, etc., and Smaridinae, including *Smaris*, *Smaridia*, etc.

From an examination of the literature accessible the opinion seems to be quite generally held among recent authors that the Water Mites as a whole form a group of higher rank

than that of a family, and in the judgment of the writer this opinion is well founded. A careful consideration of the subject involving an earnest study of previously proposed arrangements and a careful weighing of the value of the characters offered by these forms has so far not led to results that the author is willing to publish as final, but the following tentative scheme is suggested to indicate the relationships of the group and its components:

Phylum—Arthropoda,

Class—Arachnoidea,

Order—Acarina,

Sub-order—Prostigmata,

Tribe I—Trombidini,

Tribe II—Hydracarini,

Fam. 1—Hydrachnidae,

Fam. 2—Limnocharidae,

Sub-fam. 1—Limnocharinae,

Sub-fam. 2—Eylainae,

Sub-fam. 3—Hydryphantinae,

Fam. 3—Hygrobatidae,

Sub-families?

It seems to the writer that no argument is necessary to explain the use of the terms above down to that of sub-order. He believes also that Kramer's position in regard to the natural character of the group Prostigmata is well taken, but it does not seem that the characters of this group are such as to be accorded more than sub-ordinal rank. The separation of this sub-order into the tribes Trombidini and Hydracarini is based on views suggested or expressed by several authors. The former is practically synonymous with Canestrini's Trombidina plus his Hoplopina, which do not seem to be co-ordinate groups, while the Halacaridae are thrown out of the Hydracarini, since as Trouessart (89) says, they seem to be intermediate between the Gamasidae and Sarcoptidae. As thus limited the Hydracarini form a well-defined and very homogeneous group, certain forms in which furnish an easy transition to the Trombidini.

The three families suggested are based on Kramer's arrangement, and are separated not only by characteristic larval types but also by structural characters of the adult, especially such as relate to the form and relationships of the mouth-parts. The sub-families of the Limnocharidae are also based on both larval and adult characters. As to the possibility of further division of the Hygrobatidae on characters that are essential or natural the author at this time reserves his opinion. He would, however, present for consideration the following propositions:

1. The tribe Hydracarina as defined above is polyphyletic in origin as evidenced by the wide difference between the three larval types.

2. The uniformity of conditions under which the species exist has led to a great similarity of structure among adults.

3. The group becomes thus both sharply limited and very homogeneous.

4. The characters of the early stages reveal more of the phylogenetic relationship than do those of the adult.

5. On the other hand, owing to the same uniformity of conditions the forms are unusually conservative, and specimens from widely separated regions and very different localities show practically no variation.

6. The structural characters presented by the adult may in consequence be accepted as possessing a maximum value in classification.

8. In the division of the tribe into families and then into sub-families the natural grouping of the genera must depend on the characteristics of the larvae, to which should be added in the definition of the group the common structural characters of the adult.

Certain facts brought out in the study referred to earlier in this paper support these views. The genus *Koenikea* illustrates very well the constancy of the forms. Specimens collected in a small shallow pond (Cranberry Lake, Wood's Hole, Mass.) nowhere over two feet deep, and covering an area of but an acre or two, and lying out on a peninsula with a bluff on the one hand and on the other the Atlantic Ocean, from which it is separated by a narrow strip of sand; others from a lake (Lake St. Clair, Mich.) covering over 400 square miles and with a very uniform depth over the center of about 20 feet; others from lakes (near Grand Rapids, Mich.) of half

a mile to a mile and a half in diameter, and 60 to 80 feet in depth; others from a small artificial pond (South Bend, Nebr.) separated by 1,500 miles from the first locality named; others from a narrow prairie slough (Wayne, Nebr.) the remnants of a former creek bed; and still others from among the reeds and rushes in a rapidly flowing river (Grand River, Mich.)—all are on careful examination quite indistinguishable, and altogether nearly 100 specimens have been examined without the detection of an appreciable variation.

The homogeneous character of the group must be evident to every student of these forms, at least if his experience be similar to that of the writer, who approached the study of them quite unprepared for the wonderful variety exhibited by the details of structure which have become apparent after careful examination, where at first on superficial examination all looked practically alike.

The temptation is strong to continue these observations on the classification of the forms with which we are dealing, but further discussion concerning the more comprehensive groups and a consideration of the basis upon which the genera in the group should rest is withheld, to be published in another paper.

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EXPLANATION OF PLATE

All figures drawn with the aid of a camera lucida—but in Figs. 1 and 3 only certain dimensions thus secured, the rest sketched by eye.

Plate XXI

All but Fig. 6, of *Steganapsis arrenuroides* nov. sp.

Fig. 1. A portion of the meshwork formed by the exoskeleton, from near the base of one of the palpi and showing the opening of a gland. $\times$ about 375.

Fig. 2. The palpi and rostrum (r.). $\times$ 250.

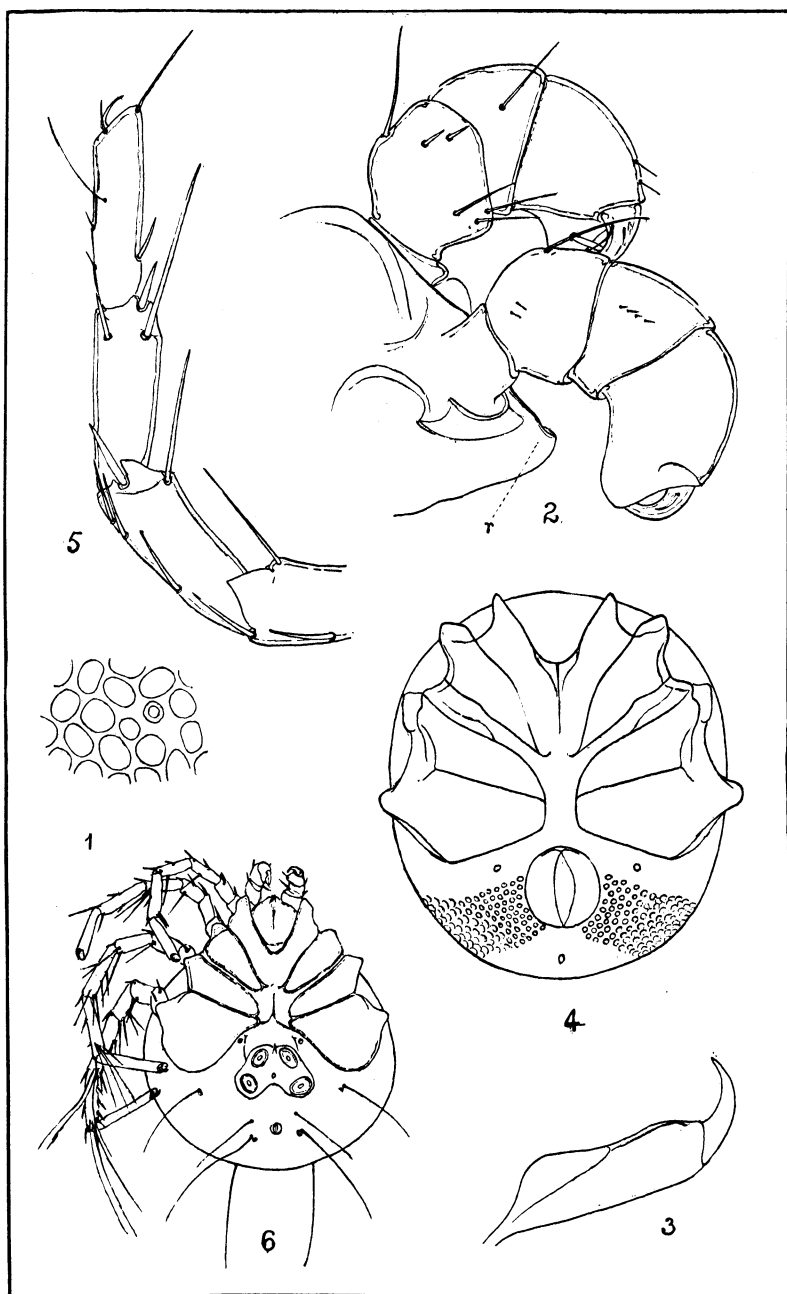
Fig. 3. The right mandible. $\times$ 250.

Fig. 4. The epimeral and genital areas, drawn from the preserved specimen before being dissected and the parts mounted on a slide. $\times$ 60.

Fig. 5. Anterior side of distal segments of the left fore leg. $\times$ 192.

Fig. 6. Ventral view of the nymph of *Krendowskia ovata* Wolc. $\times$ 75.

PLATE XXI



R.H.W. del.